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A COMMERCIAL NEMATODE FOR MOLE CRICKET CONTROL

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ABSTRACT: In Puerto Rico, the name "changa" is generally applied to *Scapteriscus didactylus* (Latreille) (Orthoptera: Gryllotalpidae), the most widespread and damaging of the non-indigenous pest mole crickets in Puerto Rico. *S. abbreviatus* Scudder is also established but much less abundant. We conducted a T-STAR project to efficiently release, establish, distribute and evaluate the entomopathogenic nematode, *Stinernema scapterisci* Nguyen and Smart (Rhabditida: Steinernematidae), for controlling *Scapteriscus* spp. mole crickets. The University of Florida negotiated an agreement with Becker Underwood for commercial production of the nematode that is available as the product, Nematac®S. The "mole cricket nematode" has been used effectively to control non-indigenous mole crickets in pastures and turf in Florida since the early 1990s. It parasitizes only *Scapteriscus* spp. in nature and not indigenous mole crickets that are in a different genus, so it is safe to import and release. The level of mole cricket infection, nematode establishment and dispersal, and suppression of mole cricket populations is being quantified. This project provided data on the occurrence and life history of *Scapteriscus* spp. mole crickets and on the efficacy of the nematode product. It assisted in establishing markets for Nematac®S in Puerto Rico and will eventually help distribute the nematode across the island to maintain invasive mole crickets at non-economic levels.

INTRODUCTION

Mole crickets were first reported from Puerto Rico in the 18th century, the result of a French expedition in 1797 that included 46 insect species. At lease one mole cricket specimen was supposedly deposited in the Paris Natural History Museum but none have been located. The first species to have been reported in the 19th century was *Neocurtilla hexadactyla*, under the name *Gryllotalpa hexadactyla*. In the 20th century, Wolcott (1941) stated that the 19th century records should have referred to *Scapteriscus vicinus* and we have not found specimens of *N. hexadactyla* from Puerto Rico in museum collections. Several publications reported that *S. didactylus* (Latreille) (Orthoptera: Gryllotalpidae) arrived in guano shipped from Peru to Mayaguez in about 1850 (Barrett, 1902). Unfortunately, by 1918, economic entomologists in Puerto Rico and elsewhere in the Caribbean concluded that the name of this species should be *S. vicinus*. This name has persisted in the economic entomology literature; however, the correct name is *S. didactylus*. Castner and Fowler (1984) collected this species inland and from several locations near the coasts. *S. abbreviatus* Scudder was recorded in Puerto Rico early in the 20th century (Wolcott, 1924) but there is no indication of how it arrived. It was collected by Castner and Fowler only on the north coast, specifically Isabela, Arecibo, and Rio Piedras. *S. imitatus* was reported in Puerto Rico in the early 1980s and was thought to have been accidentally introduced about 1940. Castner and Fowler collected *S. imitatus* only at Isabela and Arecibo but apparently did not encounter *N. hexadactyla*.

In the early decades of the 20th century, Puerto Ricans blamed damage to many crops on feeding and tunneling by mole crickets, specifically the West Indian mole cricket, *S. didactylus* (Zwaluwenburg, 1918). Currently, it is the most widespread pest mole cricket in the Caribbean, called the "changa" (Nickle and Castner, 1984; Frank et al., 2002; Frank and Walker, 2003). It damages turf, pastures and certain crops, sometimes severely, and was named "the worst insect pest of general agriculture." *S. abbreviatus* Scudder is also established in Puerto Rico but is much less abundant. There is no mention in the Puerto Rican economic entomology literature of *S. abbreviatus* or *S. imitatus*.

To control the changa, Puerto Rican entomologists imported and established a sphecid wasp, *Larra bicolor* Fab., from Brazil in the late 1930s to early 1940s (Martorell, 1939; Wolcott, 1941). They apparently did not attempt to evaluate its effect on *S. didactylus* populations. Wolcott noted the importance of a wildflower, *Spermacoce verticillata*, called botón blanco in Puerto Rico, as a nectar source for the wasp. However, nobody in Puerto Rico seems to have grown the wildflower to promote wasp populations. Accounts of damage by mole crickets in Puerto Rico declined almost to zero within a few years after the wasp was established. That might indicate effectiveness of the wasp, availability of more effective chemical pesticides, or changes in the pest status of changas. Recently, golf courses in northeastern Puerto Rico reported significant damage due to mole crickets.

The worst pest mole cricket in Florida is the tawny mole cricket, *S. vicinus* (Frank and Parkman, 1999). To control this non-indigenous species and two others in the genus, University of Florida entomologists and nematologists introduced three natural enemies originally from the pest mole cricket's source in South America (Nguyen and Smart, 1989; Parkman and Smart, 1996). One of these beneficials, the nematode *Steinernema scapterisci* Nguyen and Smart (Rhabditida: Steinernematidae), is very effective in controlling the tawny mole cricket. The other two are *L. bicolor* (Frank et al., 1995) and *Ormia depleta* (Wied.), a tachinid fly (Frank et al., 1996).

The nematode is now produced commercially and distributed in the southeastern U.S. and Puerto Rico by Becker Underwood as the biopesticide product Nematac®S (http://www.becker underwood.com/labels/nematac.html). It is being sold primarily for large-scale use on golf courses and pastures, but is available in small quantities from Gardens Alive. It is not just a biopesticide because it establishes potentially permanent populations. In Florida, it has been detected in substantial numbers eight years after release in pastures and twelve years for golf courses.

The overall goal of this project was to import, release and evaluate the effect of the entomopathogenic nematode, *S. scapterisci*, on *S. didactylus* in Puerto Rico. Specific objectives were to: 1. import the nematode into Puerto Rico, 2. release large quantities on sandy and clay loam soils, and 3. evaluate its effectiveness in controlling the West Indian mole cricket.

METHODS AND MATERIALS

We collected mole crickets from coastal areas around the island and at inland locations using soap flushes to determine their presence and abundance (Hudson, 1989). University of Puerto Rico research stations at Fortuna, Isabela, and Lajas were also surveyed for mole crickets because they offered logistical support and security. However, since there was no clear evidence of the pests at the stations, we selected other research sites in western Puerto Rico and installed

pitfall traps to continuously monitor the mole cricket populations: Aguada, Aguadilla, Mani, San German, Playa Añasco, Playa Jobos, and Playa Joyuda. A student employee from Mayaguez could visit all of these sites within a single day. A more distant site at Jayuya was added because a resident was willing to operate one trap. The study sites represented a field planted in peanuts, one planted in tomato, three golf courses, a turf farm, a backyard with low quality turf and an occasional vegetable patch, a small organic vegetable farm, a seaside recreational area with low quality turf, and an historic site with turf. Sites with sandy soils were mostly unsuitable for research because of frequent agricultural or public disturbances. However, we applied nematodes on the organic vegetable farm twice in (Aguada) and at an irrigated golf course with clay loam soil near (Aguadilla).

The nematodes were produced by MicroBio, UK and provided by Becker Underwood, Ames, Iowa (http://www.beckerunderwood.com) under a use license from the University of Florida, the patent holder. The nematodes were shipped directly to the University of Puerto Rico at Mayaguez, stored for no more than one month at about 10°C, reformulated in water and released. The applications were made in November 2001, May 2002, and November 2003 by using a small truck-mounted 150-gal. spray tank or commercial spraying equipment, without irrigation, early in the morning or late in the afternoon to avoid direct sunlight. Soil conditions were almost perfect due to rain before, during and after the applications at both sites. Plot size varied at the release sites, so the number of nematodes was adjusted to 800 million per acre, the standard amount, and applied in 100 gal. of water per plot (Parkman et al., 1993). Mole crickets were captured in arrays of pitfall traps, removed and identified at 7-day intervals, and examined for nematodes.

Methods were developed for importing, shipping, storing, using, and evaluating the new nematode product, Nematac®S. USDA-APHIS-PPQ permits required to import and release the nematodes were obtained in cooperation with regulatory officials at Riverdale, Maryland and San Juan, Puerto Rico. The project provided assistance to Becker Underwood in obtaining a permit to import commercial quantities of Nematac®S into Puerto Rico. Pitfall traps were constructed and installed at each site to measure and track mole cricket populations (Hudson, 1989). We used five 0.5-acre treatment plots and five untreated plots of the same size, each with a new or reinstalled pitfall trap at or near its center. Mole crickets pitfall-trapped at each of the sites were taken alive to the laboratory, provided with food and water, and held until they died.

Mole crickets that died and contained nematodes were sent to the University of Florida for identification by Drs. Khuong B. Nguyen and Byron J. Adams. It is remarkable that none of the immature mole crickets captured and reared survived to the adult stage. At the organic vegetable site, phorid flies attacked dead mole crickets in the traps and caused rapid decomposition, interfering with the detection of nematodes.

RESULTS AND DISCUSSION

Soap flush and pitfall trap collections produced additional distribution records and life cycle information for mole cricket species in Puerto Rico. Mole crickets trapped and identified at the release sites were *S. didactylus* (at both sites) and *S. abbreviatus* (at one site). We have not encountered *N. hexadactyla.* Zwaluwenburg (1918) studies of the life cycle of *S. didactylus* in detail and called it *S. vicinus*. These studies note that reproduction may occur throughout the year, although with seasonal peaks of activity. Life cycles of the other two *Scapteriscus* spp. have not been studied in Puerto Rico, although our work provided some data from routine pitfall

trap collections. It is unclear why captured, healthy immature mole crickets could not be reared to the adult stage in Puerto Rico. This kind of rearing is done routinely in Florida with *Scapteriscus* spp (Frank, 1994) and the diet used in Puerto Rico was supplied from Florida.

In December 2001, mole crickets trapped at both study sites were infected in the field by the released nematodes. In 2002, non-pathogenic rhabditid nematodes were obtained from mole crickets collected from six sites. Steinernematid nematodes were obtained only from the two sites where nematodes had been applied. All steinernematid nematodes were *S. scapterisci*. Thus, there is no evidence of a native steinernematid nematode capable of killing *Scapteriscus* spp. mole crickets in Puerto Rico.

Mole crickets infected with *S. scapterisci* continued to be collected from the golf course site through the end of June 2002. Persistence of *S. scapterisci* for over seven months at the golf course site suggests that a population did become established. Research from Florida showed that the nematode is not likely to persist for more than 10 weeks in the soil without passing through host mole crickets. Thus, we have shown that *S. scapterisci* infects and kills *S. didactylus* mole crickets in Puerto Rico.

Nematode applications on the organic vegetable farm failed to achieve establishment twice. Subsequent laboratory studies confirmed very poor survival of the nematodes in that soil. The soil had been enriched with compost to achieve a 6% level of organic matter and probably supported bacteria or fungi antagonistic to the nematodes. One of the sites with clay loam soil also proved unsuitable for the nematodes because it was not irrigated and the mole cricket populations were inconsistent. We are continuing to monitor mole crickets and their nematode infection levels in Puerto Rico. The effect of soil type on the survival of mole cricket nematodes is also being studied.

We have generated significant information that is needed to use biological control for managing pest mole crickets in Puerto Rico. Nematac®S kills West Indian mole crickets and the nematodes persist in irrigated clay loam soils. We also have begun to evaluate the impact on mole crickets of the wasp, *Larra bicolor*. Certainly, the mole cricket nematode can function as an effective natural enemy in Puerto Rico and elsewhere in the Caribbean.

REFERENCES

Barrett, O.W. 1902. The changa, or mole cricket (*Scapteriscus didactylus* Latr.) in Puerto Rico. Porto Rico Agr. Expt. Stn Bull. 2: 1-28.

Castner, J.L., and H.G. Fowler. 1984. Distribution of mole crickets (Orthoptera: Gryllotalpidae: *Scapteriscus*) and the mole cricket parasitoid *Larra bicolor* (Hymenoptera: Sphecidae) in Puerto Rico. Florida Entomol. 67:481-484.

Frank, J.H. 1994. Biological Control of Pest Mole Crickets, pp. 343-352. *In* D. Rosen, F.D. Bennett and J.L. Capinera (Eds.). Pest Management in the Subtropics, Biological Control- a Florida Perspective. Intercept. Andover, England. 737 p.

Frank, J.H., and J.P. Parkman. 1999. Integrated pest management of pest mole crickets with emphasis on the southeastern USA. Integrated Pest Management Reviews 4:39-52.

Frank, J.H., J.P. Parkman, and F.D. Bennett. 1995. *Larra bicolor* (Hymenoptera: Sphecidae), a biological control agent of *Scapteriscus* mole crickets (Orthoptera: Gryllotalpidae), established in northern Florida. Florida Entomol. 78: 619-623.

Frank, J.H., and T.J. Walker. 2003. Mole crickets (Orthoptera: Gryllotalpidae) in Jamaica. Florida Entomol. 86: 484-485.

Frank, J.H., T.J. Walker, and J.P. Parkman. 1996. The introduction, establishment and spread of *Ormia depleta* in Florida. Biological Control 6: 368-377.

Frank, J.H., R.E. Woodruff, and M.C. Thomas. 2002. Mole crickets (Orthoptera: Gryllotalpidae) in Grenada, West Indies. Entomotropica 17: 207-212.

Hudson, W.G. 1989. Field sampling and population estimation of the tawny mole cricket (Orthoptera: Gryllotalpidae). Florida Entomologist 72:337-343.

Martorell, L.F. 1939. Methods of collecting and shipping *Larra americana* Saussure, a parasite of the Puerto Rican mole-cricket. Ann. Entomol. Soc. Amer. 32: 703-712.

Nguyen, K.B., and G.C. Smart, Jr. 1989. A new steinernematid nematode from Uruguay as a biological control agent of mole crickets. (Abstracts, 28th Annual Meeting Soc. Nematol.). J. Nematol. 21:576.

Nickle, D.A., and J.L. Castner. 1984. Introduced species of mole crickets in the United States, Puerto Rico and the Virgin Islands (Orthoptera: Gryllotalpidae). Ann. Entomol. Soc. Amer. 77: 450-465.

Parkman, J.P., W.G. Hudson, J.H. Frank, K.B. Nguyen, and G.C. Smart, Jr. 1993. Establishment and persistence of *Steinernema scapterisci* (Rhabditida: Steinernematidae) in field populations of *Scapteriscus* mole crickets (Orthoptera: Gryllotalpidae). J. Entomol. Sci. 28:182-190.

Parkman, J.P. and G.C. Smart. 1996. Entomopathogenic nematodes, a case study: Introduction of *Steinernema scapterisci* in Florida, USA. Biocontrol. Sci. Technol. 6:413-419.

Wolcott, G.N. 1924. "Insectae Portoricensis." A preliminary annotated check-list of the insects of Porto Rico, with descriptions of some new species. J. Dept. Agric. PR 7: 5-313.

Wolcott, G.N. 1941. The establishment in Puerto Rico of *Larra americana* Saussure. J. Econ. Ent. 34: 53-56.

Zwaluwenburg, R.H. van. 1918. The changa or West Indian mole cricket. Puerto Rico Agr. Expt. Stn Bull. 23-1-28.

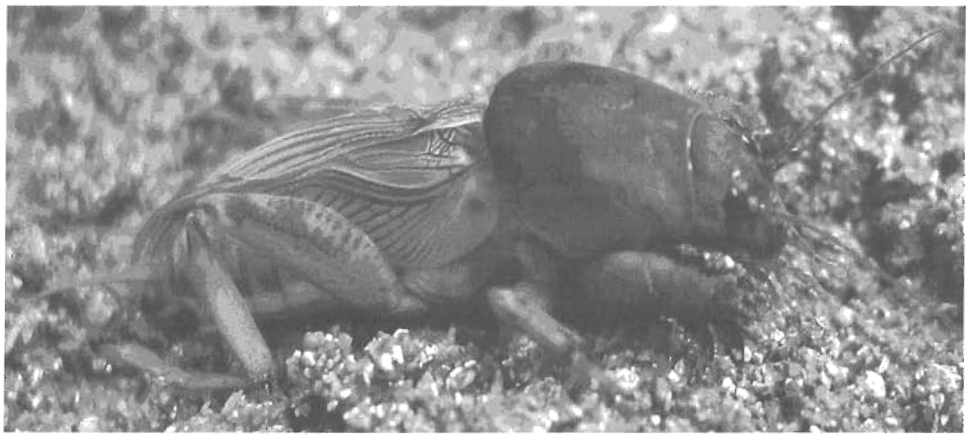

Figure 1. *Scapteriscus didactylus*, the "West Indian mole cricket" or "changa," is thought to have arrived in the West Indies by flying from South America hundreds of years ago (photographed by Luis Collazo).